

BREEDING PLACES OF ANOPHELINE MOSQUITOES IN FREETOWN, SIERRA LEONE

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PLATES XXVII TO XXXI AND THREE MAPS

Stephens and Christophers (1900) stated 'in Freetown we found that during the dry season the streams were the main source of *Anopheles*.' Daniels (1901), in a letter to Sir Ronald Ross bearing on the anti-mosquito operations then proceeding in Freetown, expressed the opinion that in the dry season, while the surface collections of water would have disappeared, new breeding-places would arise, 'mainly the streams, small and large, which remain, possibly some of the other wells and artificial collections of water in tubs, etc.' Boyce, Evans and Clarke (1905) mention 'the great disadvantage which attaches to the streams in the dry season, viz., that they constitute in Freetown, at that period, the chief sources of *Anopheles* supply.'

With the object of ascertaining whether the streams referred to above, which traverse Freetown, still act at the present day as breeding-places of anopheline mosquitoes, I took the opportunity of examining them at the end of the dry season of 1921. The search for larvae was carried out in the month of May, at which time the stream beds contained comparatively small amounts of water. The plan adopted in making the survey was to start at the mouth of the stream at the point of entry into the sea and to work up stream through the town until the places of origin of the streams was reached in the high ground at the foot of the hills behind the town; the various tributaries were followed in turn.

The results obtained showed that in each stream in which larvae were found, breeding-places were present in largest numbers at the

lower end of the stream; as one proceeded upwards through the town the breeding-places and the numbers found became scanty, while on emerging from above the town breeding places were again found, but still in small numbers in comparison with those at the lower end of the streams.

The reasons for this distribution are doubtless numerous, but some of them are clearly connected with the conformation of the ground. The streams, in some cases, by the time they reach a point several hundred yards from the sea have produced wide, steep-sided gorges through which they pursue a tortuous, irregular course; the numerous sheltered bends, overgrown with grass and weed, afford excellent breeding-grounds and shelter for the larvae. The process of erosion in the wet season appears to have more than compensated for the additional volume of water to be carried, so that the advantage of flushing is to a certain extent lost in the lower portions of the streams. In the town proper the streams are passing through a rocky formation, with the result that there is slower erosion; this and the great amount of canalisation of tributaries which has been carried out in recent years permit of more complete washing out of the stream bed in its passage through the town. Above the town the prevalence of larval breeding-places was to be anticipated from the more diffuse nature of the water courses, their extensive area, and the plentiful vegetation through which the water slowly percolates before forming definite streams. The conformation of the ground, while it favours the presence of *Anopheles* by providing suitable breeding-places, acts also in their favour, especially in the gorges mentioned above, by rendering it difficult to obtain access to these breeding-places for the purpose of detecting them, and still more by rendering the application of the measures necessary for their eradication very laborious.

The maps appended show (Nos. I and II) the places in which anopheline larvae were discovered and the manner of their distribution in 1921 and 1900. It was observed that the residual breeding-places in the streams at the end of the dry season are of two kinds. The first is the edge of the winding and eroded bed of the stream just before its entrance to the sea, the second is the shallow water, well protected by vegetation and extending over a large surface, which is found at the places of origin of the streams. These residual

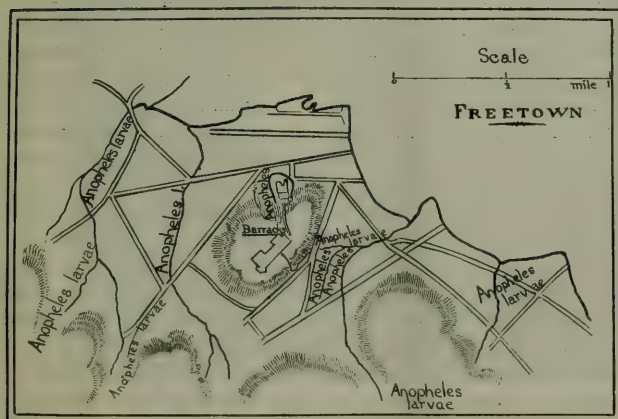


PHOTOGRAPH NO. I

Anopheline breeding place, in the town. The man is standing in the water at the point in which *A. costalis* larvae were found. Note native house in the background, water sluggish.



MAP 1. ● *A. costalis* larvae or pupae found 1921.



MAP 2. *Anopheles* larvae found 1900.

breeding-places doubtless contribute very materially to the spread of *Anopheles* when the rains commence, and other breeding sites become available. Some of the more interesting breeding-places found are seen in photographs 1 to 5.

SPECIES OF *ANOPHELES* FOUND

Larvae and pupae collected from the various breeding-places were taken to the laboratory and allowed to develop; anophelines which emerged belonged in all cases to the species *A. costalis*. This appears at the present time to be by far the commonest anopheline breeding at the end of the dry season in Freetown. It is deserving of note that in the early days of mosquito investigation in Freetown this species predominated at the end of the wet season also. Daniels (1901) mentions *Anopheles costalis* as a common mosquito in Freetown, and further states that '*A. funestus* was found near but not in Freetown.' Ross, Annett and Austin (1902) stated that while of over two hundred anophelines obtained from Wilberforce Barracks all were *A. costalis*, they obtained from Dr. Berkeley at Kissy both this species and also *A. funestus*, the latter 'by far the more numerous.' They add that *A. funestus* was restricted entirely to the eastern part of the town, and that they never found a larva or an adult of this species west of Government House. It is not stated, however, how near to this dividing line *A. funestus* existed on the east side at that time. Thus, while there is no evidence from the foregoing and the present survey that the proportion of *A. funestus* to *A. costalis* has undergone a change during this period of years, there is considerable evidence to show that *A. costalis* was then, and is to-day, the commonest anopheline in Freetown. Owing to lack of time, little could be done in the way of dissections of adults, either caught wild or experimentally fed on malaria carriers; this will be reserved for a further date, when it will be of great interest to discover whether there exist to-day any rates of mosquito infection comparable with the Wilberforce Barracks figures of Ross and collaborators in 1902, namely, twenty-seven infected *Anopheles costalis* in one hundred and nine captured females dissected.



PHOTOGRAPH NO. 2

Anopheline breeding place, above the town. The water is sluggish and almost concealed by vegetation. Numerous *A. costalis* larvae found to left of man.

It may be said then that the results obtained in 1921 at the end of the dry season were such as to confirm the predictions of twenty years ago, and in view of the great amount of careful and pains-taking work which has been steadily carried out in the interval with a view to abating mosquito breeding, it is clear that in these streams we have a problem which will require a little more detailed investigation.

METHODS OF DEALING WITH THE STREAMS

Previous suggestions as to how such an obvious source of *Anopheles* could be dealt with have been of various kinds. Some of these may be mentioned.

Daniels (1903) wrote: 'Two possible methods which are most obvious are the formation of a central channel in the bed of the stream, with larger collections of water in sufficient numbers of places for drinking purposes, and, lower down the stream, other places for washing, etc. The second, which might be cheaper but certainly less effective, would be to dam up the streams so as to obtain a sufficient head of water to flush out the whole channel at intervals.'

Boyce, Evans and Clarke (1905) summarised their views on this matter as follows:—

- (1) Reconstruction of the bed of streams.
- (2) Diversion of water for flushing of town drains in dry weather.
- (3) Construction of dams in streams and flushing of beds at intervals.

It will be seen that schemes one and three here correspond to the two suggested by Daniels above. The town drains referred to, in number two, are the surface drains in the streets.

(1) *Reconstruction of the bed of streams.*

If one follows such a stream as Nicol's Brook from its origin above Foulah town to the point where it enters the sea, it is realised that the operations involved in this scheme would be of great magnitude. The process of erosion has been so irregular in its action that the water does not flow on a simple slope from above down to the sea

level. It forms at places considerable falls, and also has cut very large cavities in the bottom of the stream bed. Laterally also it extends in different places to very different dimensions. In order to rectify the levels and build a channel capable of carrying all the rainy season water, it appears that a very large expenditure would be involved. If when this expenditure had been made the streams could then be regarded as safe, it might be a plan worthy of consideration: but it appears probable that constant attention would be required to ensure that the lateral tributaries discharged properly into the central channel and that pools did not form outside this channel itself. This would involve one of two things. Either the channel would have to be so levelled and sloped at the sides that no pools could possibly form—a vast operation—or else such pools would have to be treated regularly with larvicide, as at present. The other streams would require similar measures.

(2) *Diversion of water for flushing of town drains in dry weather.*

This scheme would, it appears to me, fail to be effective in preventing anopheline breeding in the stream beds, for two reasons. One is that water oozing out of springs between the strata in the bed of the stream would still form pools suitable for breeding anophelines. The other is that many of the drains referred to discharge into these streams and would thus carry the water back to the bed of the stream after having flushed out the town street drains.

(3) *Construction of dams in streams and flushing of beds at intervals.*

This scheme assumes that the bed of the stream is capable of being effectually flushed, but the observations which were made above in connection with the conformation of the streams go to prove that Nature has already by the process of excavation and erosion effectually prevented such a flushing action being successful. Further, it cannot be said that even a large volume of water passing occasionally down a river bed which is a honeycomb of pools will ensure the sweeping out of anopheline larvae from these pools. This scheme, therefore, does not appear to guarantee success.



PHOTOGRAPH NO. 3

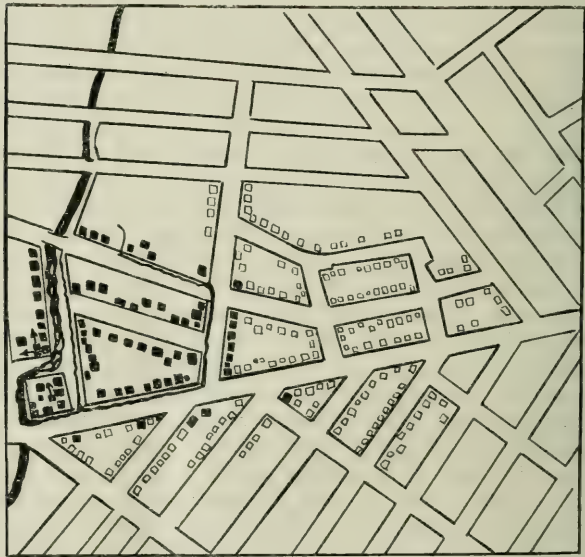
Anopheline breeding place, in stream bed in the town. *A. costalis* larvae found near bank to left of where the woman is standing.

SEGREGATION METHOD

Stephens and Christophers were among the pioneers of the segregation method of dealing with the malaria problem, and there is ample evidence of the efficacy of this method where it is vigorously and thoroughly carried out. It is chiefly of value where we are dealing with a small non-immune community which has to exist side by side with an overwhelming preponderance of immunes and semi-immunes. It is based on the fact that there always has been, and always is, a large proportion of infected children among the native population. If we believe such conditions will always remain in the future, it is clear that the readiest and most inexpensive way of dealing with such a small white community will be by strict segregation; in this way a great degree of safety from infection can reasonably be insured. In places which are being newly developed this method can be used advantageously, as also in places where the white population is small and circumstances favour their settlement away from the native. But in old established towns it is not by any means an easy method to apply, more especially where the white population is growing, and likely to grow greater year by year. It is also a method which leaves the natives to themselves and frankly regards them as so infected that no immediate and inexpensive mode of dealing with this infection is available; to this extent it is a method which is a tacit acknowledgment of defeat. Segregation occupies in respect to the malaria problem much the same place from the point of view of medical prophylaxis as evacuation of fly areas occupies in respect to the trypanosomiasis problem. Each may be excellent as a temporary expedient, but neither can be regarded as a final and satisfactory method of dealing with these problems.

The bearing of segregation on the question of how to deal with the streams of Freetown is clear when we consider the results obtained by Stephens and Christophers in their investigation on the anopheline content of these streams and the native houses situated close to them. I have obtained the permission of these authors to reproduce a spot plan (Map III) which they made in 1900, showing the distribution of adult anopheles in houses near such a stream. It will be observed that 'houses in which anopheles are present in enormous numbers' are found immediately beside the stream, that

'houses in which search in early morning reveals a few anopheles' extend back from the stream a short distance, while as we recede further from the stream we reach 'houses in which anopheles cannot be found.' The conditions depicted here would, I feel no hesitation in saying, reproduce themselves automatically immediately any considerable relaxation of the present sustained effort on the part



- ← ■ Houses in which anopheles are present in enormous numbers
 ■ Houses in which search in early morning reveals a few anopheles
 □ Houses in which anopheles cannot be found

MAP III.

of the sanitary authorities of Freetown took place. In Freetown it does not appear to me practicable now to adopt a method of rigid segregation, and moreover, even if it were practicable, it would still be advisable to deal with the problem of the streams with a view to ameliorating the condition of the native.



PHOTOGRAPH NO. 4

Anopheline breeding place, in the town. A few *A. costalis* larvae were found at points along the edge from where the man is standing; water fairly rapid.

IS A PERMANENTLY EFFECTIVE SCHEME POSSIBLE?

The only permanent scheme which will be effective in dealing with the stream beds appears to be one which obliterates them entirely. Whether any such scheme can be devised is a matter for engineers to determine. It might involve the construction of a canal or canals capable of carrying the water to east and west from above the town and reclamation of the present stream beds. The fact that the outlay required, if the scheme were practicable, would be very large indeed does not enter at present into the discussion. Whether the effective method will prove too costly need and can only be decided after considerable investigation over a period as to whether an effective scheme is practicable from the engineering point of view. It deserves investigation, however, even if apparently excluded on account of prohibitive cost, for we are not justified in assuming that an effective method which would be too expensive at present must necessarily prove so in future years.

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PHOTOGRAPH No. 5

Anopheline breeding place, in the town. Behind the rock in front of which the man is standing is the pool in which little vegetation was present; a few *A. costalis* larvae.